



King's Research Portal

DOI:

[10.1098/rstb.2010.0388](https://doi.org/10.1098/rstb.2010.0388)

Document Version

Publisher's PDF, also known as Version of record

[Link to publication record in King's Research Portal](#)

Citation for published version (APA):

Woods, A. (2011). A historical synopsis of farm animal disease and public policy in twentieth century Britain. *Philosophical Transactions of the Royal Society of London Series B: Biological Sciences*, 366(1573), 1943-1954. <https://doi.org/10.1098/rstb.2010.0388>

Citing this paper

Please note that where the full-text provided on King's Research Portal is the Author Accepted Manuscript or Post-Print version this may differ from the final Published version. If citing, it is advised that you check and use the publisher's definitive version for pagination, volume/issue, and date of publication details. And where the final published version is provided on the Research Portal, if citing you are again advised to check the publisher's website for any subsequent corrections.

General rights

Copyright and moral rights for the publications made accessible in the Research Portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognize and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the Research Portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the Research Portal

Take down policy

If you believe that this document breaches copyright please contact librarypure@kcl.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.

A historical synopsis of farm animal disease and public policy in twentieth century Britain

Abigail Woods

Phil. Trans. R. Soc. B 2011 **366**, 1943-1954

doi: 10.1098/rstb.2010.0388

References

[This article cites 43 articles, 4 of which can be accessed free](#)

<http://rstb.royalsocietypublishing.org/content/366/1573/1943.full.html#ref-list-1>

[Article cited in:](#)

<http://rstb.royalsocietypublishing.org/content/366/1573/1943.full.html#related-urls>

Subject collections

Articles on similar topics can be found in the following collections

[health and disease and epidemiology](#) (462 articles)

Email alerting service

Receive free email alerts when new articles cite this article - sign up in the box at the top right-hand corner of the article or click [here](#)

To subscribe to *Phil. Trans. R. Soc. B* go to: <http://rstb.royalsocietypublishing.org/subscriptions>

Research

A historical synopsis of farm animal disease and public policy in twentieth century Britain

Abigail Woods*

*Centre for the History of Science, Technology and Medicine, Level 2, Central Library, Imperial College
London South Kensington Campus, London SW7 2AZ, UK*

The diseases suffered by British livestock, and the ways in which they were perceived and managed by farmers, vets and the state, changed considerably over the course of the twentieth century. This paper documents and analyses these changes in relation to the development of public policy. It reveals that scientific knowledge and disease demographics cannot by themselves explain the shifting boundaries of state responsibility for animal health, the diseases targeted and the preferred modes of intervention. Policies were shaped also by concerns over food security and the public's health, the state of the national and livestock economy, the interests and expertise of the veterinary profession, and prevailing agricultural policy. This paper demonstrates how, by precipitating changes to farming and trading practices, public policy could sometimes actually undermine farm animal health. Animal disease can therefore be viewed both as a stimulus to, and a consequence of, twentieth century public policy.

Keywords: veterinary; animal health; disease; agriculture; policy; state

1. INTRODUCTION

The diseases suffered by British livestock, and the ways in which they were perceived and managed by farmers, vets and the state, changed considerably over the course of the twentieth century. This paper documents and analyses these changes in relation to the development of public policy. It examines and explains the shifting boundaries of state responsibility for animal health, the diseases targeted and the preferred modes of intervention. It also demonstrates how, by precipitating changes to farming and trading practices, public policy could sometimes undermine animal health.

In keeping with the interdisciplinary nature of this theme issue, this paper regards disease both as a biological event caused by particular micro-organisms and pathological processes, and as a social phenomenon that 'does not exist until we have agreed that it does, by perceiving, naming and responding to it' [1]. This approach differs from that of the two existing, book-length historical synoptic accounts, which regard policy either as a self-evident response to a scientifically defined disease problem [2], or as an intervention driven by society and politics rather than the characteristics of the disease in question [3]. In accepting that diseases have a 'real' existence whose understanding is mediated by society, culture, economics and politics, the integrated analysis presented here expands upon Brassley's

claim that disease 'perceptions may have more effect than the pathogens on the policies' [4]. It reveals that while policy responses were shaped partly by disease demographics and scientific understandings, they can only be fully understood by examining the context in which diseases emerged, were made visible, and were constructed as pressing problems in need of state-led solutions.

Owing to restrictions on length, a comprehensive treatment of animal disease and public policy is not possible. This paper, therefore, focuses on the more important diseases of cattle, sheep and pigs in twentieth century Britain. 'Importance' is judged mainly from an animal health, not a public health perspective. Of the food-borne zoonoses, only bovine tuberculosis (bTB) and brucellosis are addressed. No attempt has been made to examine poultry disease or animal welfare policy, and twenty-first century developments such as the growing controversy over bTB control and the movement for farm health planning, are not discussed. However, an effort has been made to push beyond the disease eradication campaigns examined by existing literature to consider other, rarely documented forms of state intervention in livestock health.

Beginning at the turn of the twentieth century, §2 explores the shift in focus of animal health policy, from the stamping out of foreign epizootic diseases to the detection and control of major endemic diseases. Moving to the inter-war period, §3 shows how animal health and policy responses to it were shaped by financial stringency, the politics of milk consumption and the reorganization of livestock marketing. Section 4 reveals

*a.woods@imperial.ac.uk

One contribution of 11 to a Theme Issue 'Interdisciplinary perspectives on the management of infectious animal and plant diseases'.

that the wartime drive to maximize meat and milk output focused the state's attention on disease as a cause of inefficient production, and led to new forms of veterinary intervention on dairy and hill sheep farms. Post-war, as shown in §5, there was a further shift in the nature and range of veterinary intervention. The state's commitment to greater and more efficient food production, and the health problems generated as agriculture intensified, resulted in national disease eradication campaigns and attempts, at farm level, to prevent the diseases of production. Towards the end of the century, ample food supplies and the escalating costs of agricultural support caused the state to roll back its investment in animal health. Section 6 reveals how this policy, and the continuing intensification of agriculture, left the nation vulnerable to new and resurgent infections, such as bovine spongiform encephalopathy (BSE) and foot and mouth disease (FMD). This paper concludes (§7) with some reflections on the relationship between animal health and public policy.

2. FROM ELIMINATION TO CONTROL, ca 1900–1920

At the turn of the twentieth century, members of the Veterinary Department of the Board of Agriculture¹ were in a buoyant mood [6]. Over the previous 60 years, the nation had suffered a series of invasions by costly contagious animal diseases. The liberalization of the international livestock trade that followed the 1846 repeal of the Corn Laws, the development of steamships and railways, and the nutritional demands of a growing, increasingly urbanized population, had contributed to the problem by enabling and encouraging livestock to be moved further, faster and more frequently than ever before [7]. State vets had fought a long and difficult battle to prevent the entry and spread of these epizootic diseases,² which by 1900 they appeared to have won [2].

Sheep pox, whose 1847 appearance had inspired the first legislative interventions in animal health, had not been seen since 1862. The highly fatal and contagious rinderpest, or cattle plague, whose ravages had prompted the 1865 formation of a State Veterinary Department (SVD), had last invaded in 1878. FMD (which appeared in 1839) and bovine pleuropneumonia (1842), whose endemic status and evasion of disease controls had provoked successive expansions in the size, scope and power of the SVD, disappeared in 1886 and 1898, respectively. Although, FMD reappeared briefly in 1892 and 1900 it was quickly eliminated. Of the major known livestock diseases, only swine fever and sheep scab remained resistant to the SVD's interventions [2,8–11].

These achievements enhanced the legitimacy of the Veterinary Department's policy of 'stamping out' disease. Applied first to cattle plague and then extended to the other epizootic diseases (apart from sheep scab, which was controlled by dipping), this policy aimed to prevent the invasion and spread of disease, and eliminate it from the nation. Measures included: restrictions on the importation and movement of livestock, and the compulsory slaughter or quarantine of affected animals and their contacts. Much resistance

accompanied the introduction and extension of stamping out. However, the SVD, supported by powerful aristocratic cattle breeders, believed that the national benefits outweighed the local and individual costs. Consequently, it continued, throughout the twentieth century, to apply stamping out to the only epizootic disease that remained a problem: FMD. This reappeared virtually every year until 1968, causing major epidemics in 1922–1923, 1923–1924, 1951–1952 and 1967–1968 [9,10,12].

With the disappearance of epizootic disease, the Veterinary Department turned its attention to two endemic, widespread and costly cattle diseases that it judged to be of national importance. bTB and contagious abortion (later known as brucellosis) were of particular concern to dairy farmers and aristocratic pedigree cattle breeders, who used their political influence and social connections to lobby for state action. bTB was a chronic, debilitating disease that undermined meat and milk production. Despite Robert Koch's 1901 statement to the contrary, it was believed to spread to humans via the meat and milk of infected cows (an issue that was considered by three Royal Commissions sitting between 1890 and 1911). Contagious abortion caused widespread abortion within herds, leading to the loss of valuable calves and milk [13,14]. Like bTB, it appeared to be increasing in prevalence, possibly due to the growing demand for milk, which induced arable farmers affected by the late nineteenth century agricultural depression to turn increasingly to dairying [2,7,15].³

Controlling bTB and brucellosis posed quite different political and technical challenges to the nineteenth century epizootics. These were not foreign invaders but familiar, endemic diseases which many farmers tolerated. The clinical signs of bTB (emaciation, coughing and an indurated udder) did not appear until disease was relatively advanced, while cows infected with brucellosis could not be identified except in the act of abortion. Consequently, stamping out—which relied on the rapid identification of disease in order to eliminate it before it had a chance to spread—could not be applied. Instead, for both diseases, and for the ongoing problem of swine fever (which was proving difficult to diagnose clinically and by post-mortem), state vets sought improved methods of diagnosis within the laboratory. Formerly, they had taken little interest in research owing to their faith in stamping out. Now, however, they viewed it as a way of making stamping out possible. Their investigations also served a professional purpose. In the late 1890s, administrative civil servants had taken over from state vets the responsibility for making and—to a large extent—delivering animal health policy. By undertaking laboratory investigations into disease, state vets sought to assert the 'veterinary' and 'scientific' as opposed to the 'policing' nature of livestock disease control, and therefore the need to restore veterinary direction of policy [11,12,14,17].

Research performed under the Board of Agriculture confirmed that tuberculin—discovered by Koch in 1890—was an effective method of bTB diagnosis. It also resulted in a diagnostic blood test for brucellosis. Unfortunately, hopes that these methods would

facilitate stamping out were not fulfilled as their application revealed the diseases to be far more widespread—and hence more difficult and expensive to eliminate—than originally anticipated. Up to a quarter of the national herd was infected. One alternative to stamping out was for farmers to attempt, voluntarily, to eliminate disease from their herds by first testing and identifying, then isolating and eventually disposing of infected cows. However, doubts surrounding diagnostic accuracy, and the time, cost and facilities required, meant that only a handful of livestock owners were prepared to adopt this practice. Of those that agreed to testing, many found it easier to send reacting cattle to market than to isolate them. Consequently, as well as curtailing disease, the tests contributed to its spread [14,17–19].

The 1909 discovery of a brucellosis vaccine elevated hopes of controlling infection. However, evidence of its efficacy in the field proved impossible to collect. Consequently, it was not incorporated into policy, though farmers who wished to pay for it could obtain supplies via their veterinary surgeon. More success was achieved with another laboratory product, swine fever serum. World War I (WWI) cut off supplies of Danish pork and bacon. It also created a shortage of cereal used for pig feeding, causing the British pig herd to shrink by 64 per cent over the course of the war [20]. In order to preserve the pig population, the SVD suspended stamping out for swine fever, and instead applied serum to potentially infected pigs. This policy was successful in reducing pig mortality and morbidity. However, it failed to stop disease spreading. Consequently, with the post-war economic crisis and resurgence in pig numbers, the Ministry of Agriculture, Fisheries and Food (MAFF) introduced in 1922 a policy of isolating sick pigs and their contacts. Owners could still request serum, but at their own expense [2,11,14].

In this way, the SVD transferred its laboratory-generated methods of bTB, brucellosis and swine fever control to the private domain. Falling back on its traditional, legislative interventions, it introduced some piecemeal and largely ineffective measures. A 1909 Order for bTB control enabled local authorities to institute a system—already applied by some progressive boroughs—of veterinary inspection and the enforced removal of clinically affected cows. Justified on the grounds that it would limit contamination of the milk supply, if not the spread of disease among cattle, it did not come into operation until 1913, only to be suspended on the outbreak of war. A 1920 Order to prevent farmers presenting cows that had recently aborted for sale in markets proved unenforceable due to the difficulty in identifying them [2,14,21,22].

This period, therefore, saw little real progress in state-led livestock disease control. Nevertheless, the SVD's activities had long-term consequences. The discovery of diagnostic tests for bTB and brucellosis laid the groundwork for their control and elimination later in the century. SVD research led to the 1905 foundation of a dedicated state veterinary laboratory, which still exists today as part of the Veterinary Laboratories Agency [23]. It also enabled state vets to

wrest control over policy from lay officials. Their claims that policy making and execution required a scientific understanding of disease were recognized in 1919, when they were awarded control of a new Diseases of Animals division within the newly founded Ministry of Agriculture and Fisheries (MAF) [11].

3. DEPRESSION AND DECLINE, 1920–1939

During the inter-war years, agriculture and the world economy sank into depression. Prices for agricultural produce slumped during the early 1920s then steadied before falling again after the 1929 Wall Street crash. By June 1933, they had dropped to pre-WWI levels [16]. This situation impacted on animal health and public policy. Another important shaping factor was the consumer politics of milk. Official recognition of its nutritional qualities during WWI had been accompanied by campaigns for higher standards of milk hygiene [24]. bTB was an important contaminant of milk. An estimated 40 per cent of dairy herds were infected, and it killed around 3000 people each year [25]. Consequently, its control became a politically pressing affair.

In 1925, MAF reinstated the 1913 Tuberculosis Order. This enabled local authorities to slaughter, with payment of compensation, cows with bTB symptoms or which produced tuberculous milk. Its implementation caused local authorities to appoint increasing numbers of full and part-time veterinary inspectors. By 1937, around one-third of all vets were so employed, gaining valuable income at a time when horse numbers were in decline and agriculture in depression [21]. The Order may have had some public health benefits in causing the slaughter of several thousand infected cows each year. Nevertheless, it was widely perceived as an inefficient method [26].

Consumer groups and many doctors voiced growing support for milk pasteurization as a means of protecting the public from bTB and other milk contaminants. MAF officials argued that pasteurization was unreliable: it could not make dirty milk clean; it imposed excessive costs on the producer; and it damaged the nutritional composition of milk. A far better approach was to improve the public's health indirectly, by tackling bTB in cows. However, owing to financial stringency, they were unable to meet the demands of the National Veterinary Medical Association (NVMA), forerunner of the British Veterinary Association (BVA), for a nationwide programme of bTB eradication [17,24–27].

In 1933–1934, bTB policy was considered by a cattle disease committee of the Economic Advisory Council (EAC), chaired by Frederick Gowland Hopkins, president of the Royal Society. Its recommendations caused MAF to introduce in 1935 an attested herds scheme linked to a system of milk grading. To gain attested (i.e. bTB-free) status, and the accompanying 1 penny bonus per gallon of milk, herds had to pass three consecutive tuberculin tests, the last of which was a free, official test. The owner had to agree to a number of rules to prevent bTB re-introduction, and the herd's status was checked at

intervals by repeat testing. The scheme was not popular. The low bonus offered, consumer confusion about milk grading, farmers' distrust of the state, and the unreliability of tuberculin meant that by 1938, only 3 per cent of herds had achieved attested status [2,17,25,27].

The EAC's report also confirmed and publicized an impression, held by many vets and farmers, of a general decline in dairy cow health. Drawing on the results of surveys performed by agricultural research institutes, it revealed that the average dairy cow remained in the herd for only half of her useful life. Fifty-eight per cent of cows were disposed of due to brucellosis, infertility, mastitis, bTB and Johne's disease, at a cost to farmers of £2.5 million a year. Brucellosis, like bTB, was present in over 40 per cent of herds, which experienced an average annual abortion rate of 9 per cent [25].

The poor state of dairy cow health can be partly attributed to the agricultural depression and the state's attempt to counter its detrimental impacts through the 1931 Agricultural Marketing Act. Under the terms of the Act, milk producers combined in 1933 to form a Milk Marketing Board (MMB). This sold milk and negotiated prices on their behalf. It was also responsible for the system of milk grading through which tuberculin testing was promoted (see above). The stability it created attracted many new converts to dairying, which was already proving popular on account of its immunity to foreign competition [28].⁴ A lack of land, buildings or labour was no impediment. Many dairy farmers kept flying herds, maintained by the purchase of freshly calved cows, which they fed on purchased feed and sold when their milk output dropped [29]. Some adopted machine milking which required less labour than traditional hand milking. However, milking machines encouraged mastitis [30], while the frequent sale and purchase of cows facilitated the spread of brucellosis and bTB [31]. In reducing milk output, disease threatened producers' contractual agreements to supply dairies with a set quantity of milk. With little faith in—or money to pay for—private veterinary aid, they responded by slaughtering or selling sick animals and replacing them with new ones, so contributing to the spread of disease. While aware of these practices and the diseases which resulted, the state made little attempt to intervene [19].

The 1933 formation of a Bacon Marketing Board—which paid farmers a 'fair' price, agreed in advance, and based on the estimated, average cost of production—had a similar impact on the health of pigs. Farmers with a below-average cost of production could potentially make high profits. Prices for cereal-based pig feed had already plummeted on account of the depression, while the growth of the dairy industry provided another cheap foodstuff: skimmed milk. These factors encouraged a move to specialist pig production, in which large numbers of pigs were housed together in specially erected, Danish-style fattening houses [32].⁵ Their owners, and vets responsible for inspecting pig carcasses in meat factories, observed that under such conditions, pigs suffered more frequently from respiratory and gastrointestinal disease. Again, the state—and

most practising vets—took little interest, confining their interventions in pig health to swine fever, which remained endemic [33–35].

While no marketing board was established for sheep, the depression took its toll on their health. As prices dropped, hill farmers tried to save money by reduced shepherding, less active pasture management, and retaining sheep on the same pastures over winter instead of paying for their keep on lower lying farms. They also neglected their statutory duties to dip sheep against scab. The result was under-nutrition and deficiency diseases, tick-borne, parasitic and bacterial disease, unobserved deaths from unknown causes, and poor lamb survival [2,36].

The inter-war years were, therefore, characterized by a general decline in livestock health, and a failure of bTB policy. Just before World War II (WWII), however, the state adopted a more active animal health policy. Faced with looming hostilities and the need to plan for food production in wartime, it proposed, under the 1937 Agriculture Act, a large-scale campaign to eradicate diseases, such as bTB, brucellosis, Johne's and mastitis, with resources directed to bTB in the first instance. To perform this task, it brought together the full and part-time veterinary inspectors attached to central and local government to form a single, centralized State Veterinary Service (SVS). Reflecting the shift in policy emphasis, MAF's Diseases of Animals division was renamed the Animal Health division (AHD). In 1938, it introduced a more popular bTB-attested herds scheme with improved market incentives. It also planned to institute national brucellosis testing in 1939–1940 [2,21,37,38]. This plan, together with the Agricultural Research Council's (ARC) establishment of a field station at Compton for brucellosis vaccine research [39], represented a long over-due response to the 1928 identification of a link between brucellosis and undulant fever in humans [40]. However, all initiatives were disrupted by the outbreak of war.

4. ENHANCING THE FOOD SUPPLY IN WARTIME, 1939–1945

The ways in which the state perceived and responded to livestock disease changed markedly during WWII. These changes were precipitated by a broader reorientation of agricultural and food policy. In wartime, Britain could no longer maintain its heavy, inter-war reliance upon imported food, fertilizer and livestock feed. To secure the feeding of the nation, the state took charge of food production and distribution. It introduced fixed prices for farming produce—which significantly elevated farmers' incomes—and rationing for consumers. Farmers were instructed by members of state-appointed County War Agricultural Executive Committees on the types and quantities of food they should produce, and the best methods of doing so [41–44]. The resulting, often dramatic changes in farming systems had important implications for animal health.

Specialist pig production was undermined by the need to preserve cereals for human consumption. Pig numbers dropped by 65 per cent as the scale of production shrank and shifted to mixed farms and urban

back-yards, where pigs were fed on farming by-products and swill, respectively. The respiratory and gastro-intestinal diseases of intensive pig production gave way to digestive complaints. Meanwhile, the inclusion of uncooked, infected meat scraps in swill led to an increase in swine fever and FMD, which were tackled by the 1942 establishment of swill-boiling plants run by the government's Waste Food Board [10,44–46].

Dairy farming was actively encouraged by the state. This was because nutrition experts defined milk as a 'protective food' essential for health. It could also act as a protein substitute for foreign meat, butter and cheese [28,47]. However, much of the grassland used to feed cows was ploughed up to grow crops for human consumption, and imported, manufactured feed was in short supply. Therefore, farmers had to grow their own fodder crops. The change in diet caused milk production to fall. Although dairy cow numbers were actually increasing, by 1941–1942, production stood at 88 per cent of pre-war levels [43,44].⁶

One way of improving milk output was to tackle disease. However, MAF's planned pre-war campaigns against bTB and brucellosis could not be implemented owing to shortages of manpower and laboratory equipment. In November 1940, the NVMA proposed a quite different course of action. Its leading members had carried out a survey which showed that brucellosis, infertility, mastitis and Johne's (the four diseases pinpointed by the EAC's earlier report) were jointly responsible for losses of £17 million or 200 million gallons of milk each year. They argued that vets were quite capable of managing these diseases and enhancing the milk supply. However, they rarely had an opportunity to do so because farmers typically slaughtered or sold affected cows, or treated them with home-made or patent remedies. To overcome this problem, they proposed a 'Scheme for the control of certain diseases of dairy cattle', commonly known as the 'survey' or 'panel' scheme [19].

Under the scheme, farmers paid a flat fee in return for quarterly visits by practising vets, at which herd health and reproductive status were assessed, advice offered and designated treatments performed. The NVMA asked MAF to provide publicity, subsidized brucellosis vaccines (the new S19 vaccine, recently developed in the USA) and free sulphonamides for mastitis treatment. Although initially reluctant, war-time pressures forced MAF to agree to the NVMA's proposals. The National Farmers Union (NFU) also pledged its support. The scheme was introduced on a voluntary basis in May 1942. Uptake peaked in February 1945 then declined until 1951 when it was terminated. Brucellosis vaccination proved so successful that MAF introduced its own subsidized calf vaccination scheme in 1944. The same year, it reopened its attested herds scheme [19].

The NVMA drew up a similar scheme for the control of sheep diseases, but this was not implemented. Instead, MAF took charge. Action was clearly needed. The fixing of wool prices by the Ministry of Supply to aid the manufacture of military uniforms had further undermined the hill sheep farming economy. A compensatory subsidy for hill ewes, introduced in 1940, saved many farmers from bankruptcy, but caused a further decline in sheep

health by encouraging overstocking. Vaccines against the major infectious diseases, notably clostridial diseases and louping ill, had been available for years, but were rarely used as farmers tended to accept disease losses or apply their own traditional remedies [36,44,47].

In the first year of the war, MAF tried to draw up a scheme for supplying cheap vaccines and sera to hill sheep farmers via veterinary investigation officers. Part of the SVS and stationed in regional centres, these officers offered a free diagnostic service to farmers, and provided technical advice via private vets. The plan foundered due to the resistance of private vets and drug companies [48]. In the summer of 1942, MAF seconded 15 of its regular veterinary staff to hill sheep farming areas to survey disease problems and advise on their resolution and prevention. This initiative was more successful. By the end of the war, officers reported that sheep farmers had become disease conscious. Realizing that losses were not inevitable, they had begun to consult vets when disease occurred, and to make greater use of vaccines and sheep dips [49]. The latter contributed to the elimination of sheep scab from Britain in 1952 [2].

Thus, in hill sheep farming as in dairying, war caused farmers, vets and the state to identify, problematize and tackle jointly a range of specific diseases whose prevalence threatened the nation's capacity to feed itself. Formerly disregarded or viewed as private farming concerns, these conditions were transformed into public problems that required state-supported veterinary intervention. The interventions adopted were very different from the state's pre-war campaigns against disease. They involved new organizational structures—the private/public partnership of the dairy cow scheme, and advisory services to hill sheep farms—and had new ends in view: the education of farmers, and to prevent as well as resolve disease at the herd level. These developments provided an important foundation for post-war initiatives. They also enabled the veterinary profession to build a closer relationship with farmers and the state, and to develop its expertise and reputation as 'physician of the farm' [19].

5. THE PREVENTION AND ERADICATION OF DISEASE, 1945–1980

The 35 years after WWII were the heyday of state veterinary activity. This activity was made both possible and desirable by a more general state-led drive, under the 1947 and 1957 Agriculture Acts, to increase the quantity and efficiency of food production. Motivated by the post-war global food shortage, and the need to minimize imports in order to preserve scarce sterling supplies [44,50], this expansionist agricultural policy maintained the wartime practice of subsidizing production.⁷ The resulting shift to more intensive farming methods had paradoxical consequences for animal health. On the one hand, it accelerated the wartime trend of viewing disease as a significant impediment to production, and drove new attempts to research, control and prevent it. At the same time, novel farming methods—adopted in an attempt to increase productivity—provided new opportunities for disease to emerge and spread. The demographics of disease were

therefore changing at a time when disease was perceived as a greater problem than ever before.

The implications for MAF's AHD were twofold. Firstly, at a national level, it was finally able to introduce schemes for the eradication of the major endemic diseases: bTB, swine fever and brucellosis. Although the pasteurization of milk, made compulsory in 1949 (except for farmers selling milk direct to the public), had removed the major public health risks posed by bTB and brucellosis, their effects on agricultural productivity were thought sufficiently serious to merit large-scale, expensive eradication campaigns [26]. Secondly, at farm level, it worked in conjunction with the veterinary profession (and to a lesser extent, the NFU) to develop new ways of promoting herd health and productivity through the application of veterinary preventive medicine.⁸

MAF's disease eradication campaigns built on the foundations established earlier in the century. Subsequent research had resulted in more reliable tuberculin, improved methods of diagnosing and vaccinating against brucellosis, and a new vaccine against swine fever. These technologies were used to reduce disease incidence to a level at which stamping out appeared feasible. The bTB campaign began in 1950 with an area eradication plan. By then, 22 per cent of the nation's cattle were enrolled in the attested herds scheme. Over the next decade, areas containing high percentages of attested cattle were successively identified as 'attested areas' and subjected to compulsory tuberculin testing and slaughter of infected cattle. The whole country became attested in 1960, at a total cost of £250 million. Eradication was optimistically predicted. Attention then turned to swine fever. Crystal violet vaccine had been available since 1947 and its application subsidized since 1953 under a swine fever registered vaccinated herds scheme. In 1963, with disease at a relatively low ebb, MAFF reinstated stamping out. Progress was extremely rapid. Vaccination was banned in 1964, and in 1967 the disease was eradicated [2,51].

Brucellosis was the next target. Following a long period of disease control under the state-subsidized calf vaccination scheme, MAFF introduced in 1967 an accredited herds scheme similar to that applied to bTB, with vaccination phased out in attested areas. However, because there was no requirement to slaughter reactors, they frequently ended up on the open market. The resulting spread of infection was compounded in 1967–1968 by the large-scale purchase of dairy cows by Cheshire farmers, who had lost their stock to one of the most devastating FMD epidemics on record. Problems were also encountered in vaccination and diagnosis: disease sometimes appeared in immunized herds, while diagnosis threw up a number of false positives. It was not until the 1970s, with the introduction of an additional (45/20) vaccine, new testing regimes (involving three different diagnostic tests), the brucellosis incentives scheme (which rewarded farmers for clearing their herds of disease), and a law to ban the sale of reactors, that infection levels dropped to a point at which eradication became possible. From 1971, this proceeded in the same manner as bTB. A decade later, the whole country was declared attested ([10,52]; G. Davies 2007, personal observations).

These policies were executed by SVS's full-time officers and by private vets, who were employed part-time by the SVS to act as local veterinary inspectors (LVIs). MAFF payments to LVIs increased fivefold between 1945 and 1962. Consequently, many veterinary practices became heavily reliant on state work, using it to subsidize their private services to farmers. Such services were in demand in the immediate post-war period owing to high farming subsidies, livestock values, and the development of powerful new antibiotic and anti-helminthic drugs.⁹ Able to make an ample living from LVI work, drug sales and the treatment of individual sick animals, the growing body of private vets dispensed with the preventive approach of the wartime survey scheme [19,54,55].

By the early 1960s, however, BVA leaders had begun to reevaluate the need for preventive veterinary medicine and to lobby the state to facilitate its provision on farms. They felt that the future of veterinary practice, in its existing form, was uncertain: LVI work would diminish as bTB and swine fever eradication progressed, while private work was threatened by cuts in agricultural subsidies which caused farmers to reduce their veterinary spending. At the same time, structural changes in the farming industry were impacting on animal health [54,56,57]. Farmers in search of efficiency savings were developing larger, more specialist enterprises and adopting new husbandry methods. These changes sometimes enhanced health but more usually encouraged the emergence and spread of disease. Higher stocking densities on improved pastures increased the build-up of worms in grazing animals; large, indoor pig herds suffered severe respiratory and gastrointestinal disease; dairy cows on ley pastures¹⁰ suffered metabolic diseases like bloat and ketosis; leys were also implicated in infertility, as was genetic selection for enhanced milk production, achieved through artificial insemination, a new technology encouraged and initially controlled by MAFF. Milking machines facilitated the spread of mastitis,¹¹ and disease outbreaks—most notably salmonellosis—followed the mingling and long-distance transport of calves [60–64].

These conditions were labelled 'diseases of production'. They often had low mortality and relatively mild clinical signs, but at herd or flock level, caused significant losses in productive capacity by reducing growth rates, fertility and milk production [65]. Their increasing incidence and costly impacts were made visible firstly, by a series of national and regional disease surveys, begun by the BVA and taken over by MAFF [66]; secondly, by the development of farm accounting and methods of assessing the cost of particular diseases [67–69]; thirdly, by the diagnostic work and disease surveillance performed by an expanding Veterinary Investigation Service [2,70];¹² fourthly, by the close monitoring within intensive systems, of production parameters, such as growth rate, food conversion efficiency and fertility [71]; and finally by a growing body of research into livestock disease funded by MAFF, the ARC, the Pig Industry Development Agency (Pida),¹³ and drug and feed companies [72–74].

The diseases of production were increasingly problematized following the 1957 Agriculture Act, which

reduced farming subsidies in order to encourage more efficient production [65]. Many had complex aetiologies, and could not be controlled by the growing range of pharmaceutical products.¹⁴ Consequently, BVA leaders argued that efforts should focus on disease prevention, with attention directed to the various factors (husbandry, nutrition, housing, breeding, purchasing and marketing, stockmanship) that influenced disease emergence and spread. Pointing to the National Agricultural Advisory Service (NAAS)—which had promoted farming efficiency since 1946 by offering free, expert advice to farmers in all fields except livestock health [76]—they argued that the state should subsidize vets to provide farmers with advice on disease prevention [56,57].

On account of its remit to improve agricultural efficiency, MAFF initially proved receptive to this demand. It also saw the development of a preventive medicine service as a means of gaining leverage over the NFU in the annual price review discussions, and employment for its veterinary officers when disease eradication campaigns ended [77]. In the early 1960s, it conducted an internal enquiry into the formation of a national health service for animals, which would offer free preventive medicine service to farmers [78,79]. Although it ultimately declined to form such a service, it committed itself in a 1965 white paper, ‘to think of redeploying our veterinary resources so as to concentrate more on preventive medicine to reduce the incidence of disease in general’ [80].

As a first step, the SVS established joint regional study groups with the BVA and NFU, to plan and implement local educational initiatives. These ran, with varying degrees of success, until 1972 [81,82]. It also started a pig health scheme in 1968, which provided elite breeding herds with four free veterinary visits a year (two by state vets and two by private vets) at which health was monitored and advice offered on improving herd health status [77,83,84]. However, MAFF’s tentative plans to pay practising vets to visit farms regularly and advise on disease prevention were curtailed by the economic crisis of the late 1960s [77]. It proved difficult to assess—as the Treasury now demanded—the costs and benefits of this ‘whole farm’ veterinary advice. A pilot exercise, conducted on 140 farms in conjunction with NAAS and the BVA, gave inconclusive results [85]. MAFF therefore declined to organize or to fund further substantial preventive medicine initiatives, even when recommended to do so by the committee it had appointed to consider the future role of the veterinary profession [86,87].

Consequently, the management of the diseases of production remained largely in the private domain. Practising vets tended to focus narrowly upon infectious disease control rather than applying the ‘whole farm’ approach advocated by BVA leaders. They used the Veterinary Investigation Centre’s diagnostic services, newly developed vaccines and antibiotics to control and eliminate disease from herds and flocks. To maintain disease-freedom, they advocated biosecurity and the use of disease-free animals, most notably specific pathogen free pigs which were adopted by the growing number of pig breeding companies [65,74,88].

Together with the SVS’s disease elimination campaigns and preventive medicine initiatives, these interventions proved successful in improving the health and productivity of livestock, so enabling farmers to increase their efficiency and income, and to further intensify their production practices. Vets therefore made an important contribution to the highly successful post-war food production campaign [59,89].¹⁵

6. ROLLING BACK THE STATE, 1980–2000

In 1973, Britain joined the European Community (EC) and became subject to its Common Agricultural Policy (CAP). Membership initially enabled the government to maintain its post-war commitment to agricultural protection and expansion.¹⁶ The CAP subsidized agriculture in member countries, and absorbed two-thirds of the EC’s budget. The British government saw the expansion of British food production as one way of offsetting the costs of membership. Farmers needed little encouragement to produce. Faced with rising prices for agricultural inputs, most notably labour, they continued to seek economies of scale.¹⁷ By 1980, food production was in surplus and criticisms were growing of the cost of agricultural support, and its damaging effects on the environment and animal welfare. These criticisms disrupted the post-war consensus that agricultural expansion was in the national interest, and encouraged the growth of a so-called ‘post-productivist’ outlook involving more sustainable farming systems [44,90–92].¹⁸

These developments, and the policy responses to them, had important implications for animal health. A small, organic sector emerged, whose emphasis on ‘natural’ methods of livestock production and restrictions on the routine use of veterinary pharmaceuticals resulted in new challenges to animal health [93]. In contrast, the countervailing, still dominant trend to agricultural intensification involved heavy reliance on veterinary interventions. As described above, these interventions enabled farmers to increase the intensity of production by reducing the threat and impacts of certain diseases. In so doing, they contributed to the creation of conditions that favoured the further emergence and spread of disease. Consequently, many production diseases (most notably mastitis and infertility) remained significant problems in intensive systems, not because vets and farmers had neglected them, but because their effective management of some contributing factors was counterbalanced by the emergence of new ones [94,95].

While MAFF took little interest in these diseases, it was forced to assume control of another condition that arose through attempts to achieve maximum production at lowest cost. BSE or mad cow disease was an obscure, neurological and ultimately fatal condition first recognized by MAFF in 1986. It was eventually traced to the inclusion in cattle feed of meat and bonemeal derived from the carcasses of infected cattle. In 1988, this feed was banned, and a slaughter policy introduced for infected cattle. By 1992, when the epidemic peaked, nearly 60 000 cases had been confirmed in 18 500 herds. Despite MAFF’s continuing assurance that BSE presented no risk to the public’s health, it was

forced to acknowledge in 1996 a link between contaminated beef consumption and the emergence of variant Creutzfeldt–Jakob disease in humans. This event damaged public confidence in food safety and undermined the food industry and British agriculture—which faced a decade-long ban on beef exports. In addition, the government's lack of transparency, its handling of the scientific uncertainty that had surrounded BSE aetiology, and MAFF's promotion of the interests of farmers over the public interest severely damaged public trust in policy making [96,97].

Meanwhile, a Conservative government intent on rolling back the state had come to power. In the light of food surpluses and the cost of the CAP, it announced in 1980 that it would no longer pay for the eradication of newly recognized livestock diseases. While it was forced to revise this stance in relation to BSE, pig producers had to fund, via a levy, the eradication of Aujeszky's disease, which appeared in 1979 [98]. New voluntary attested herds schemes, set up in 1982 for enzootic bovine leukosis (made notifiable in 1977) and maedi-visna in sheep (a non-notifiable disease), continued to offer free diagnostic testing. However, reactors had to be slaughtered without compensation [99]. In 1987, these diseases were incorporated into voluntary cattle and sheep health schemes covering a range of infectious diseases. Participating farmers had to contribute to the costs of these and the pre-existing pig health scheme [100].

A 1994 review of the SVS by Andy Lebrecht, principal private secretary to the Minister of Agriculture, argued that the health schemes were peripheral to MAFF's policy concerns and did not merit an annual £1.5 million government subsidy. They were subsequently privatized. This event brought to a close the state's post-war involvement in farm-level veterinary preventive medicine and heralded a new era in which it expected the agricultural industry to play a more active role in promoting animal health [100–102].

Owing to the high costs and strict protocols involved, few commercial cattle and sheep herds enrolled in the newly privatized health schemes. The pig industry, dominated by a handful of breeding companies keen to ensure the health of their stocks, proved more active. From the early 1990s, a more general stimulus to preventive healthcare was provided by the industry- and retailer-led development of farm assurance schemes. Devised in an attempt to restore consumer confidence in the wake of the BSE crisis, these required participating farmers to have a health plan. However, most plans were extremely conservative. Focusing on vaccination, medicine use and biosecurity protocols, they were 'tick box exercises' that did not necessarily require veterinary input and paid little heed to the animal health and welfare outcomes [103,104].

Lebrecht's 1994 review recognized the importance of MAFF's traditional role in the control and elimination of infectious diseases of national significance. These included bTB, whose steadily rising incidence was attributed to the existence of a wildlife reservoir in badgers [105]. However, owing to the decline in epizootic disease incidence (FMD had caused only

one, minor outbreak since the 1967–1968 epidemic) he rejected the notion that veterinary staffing levels should be kept at levels adequate to cope with disease emergencies [101]. His recommendations resulted in additional cuts to an already contracting SVS, and the closure of several regional centres. Meanwhile, the government lowered funding for agricultural and veterinary research, reduced the size of the Veterinary Investigation Service, and—in pursuit of efficiency savings—turned it and the Central Veterinary Laboratory into arms-length agencies [106,107].¹⁹

Concurrent efforts to harmonize trade within the EU, and to reform the CAP by reducing international trading barriers led to an increase in the scale and frequency of international livestock movements,²⁰ and the reappearance of FMD in several countries that were formerly free of the disease [10,91]. In the late 1990s, partly as a result of the BSE crisis and the growing power of the supermarkets to drive down farm gate prices, farmers' incomes declined. This led to further increases in farm size and livestock density, the reduced employment of private vets, and increased movement of livestock to maximize subsidy income [10,44,91,106]. These various developments contributed, at the turn of the twenty-first century, to the re-emergence of epizootic disease as a significant threat to the health of British livestock.

In 2000, swine fever broke out in Britain for only the third time since its eradication in 1966. Sixteen farms in East Anglia were infected. More than 50 000 pigs were destroyed and exports banned, at a cost of £100 million to the industry. The SVS had to divert 80 per cent of its capacity to the management of this disease. When, the following year, FMD reappeared causing hundreds of outbreaks nationwide, SVS resources proved hopelessly inadequate. MAFF's ignorance of the scale of livestock movements, the distancing of laboratory scientists from field officers, the loss of local knowledge and corporate memory in the SVS, and farmers' tendency to manage ailments themselves instead of seeking veterinary aid, impeded efforts to trace and contain the rapid, extensive spread of virus. By the time FMD was eliminated, in September 2001, by a vigorous and highly contested policy of extended slaughter, an estimated 10 million livestock had lost their lives. Exports of meat and livestock did not resume until the following year [10,106].

7. CONCLUSION

This paper has analysed the changing nature and objectives of animal health policy in twentieth century Britain, together with its drivers and impacts. It reveals a trend, from 1900–1980, of expanding state intervention, in which existing policy concerns were retained, new ones adopted and the responses to them augmented over time. While epizootic disease control was no longer as central to state veterinary activities as it had been in the nineteenth century, repeated invasions of FMD meant that it remained on the agenda. During the Edwardian and inter-war periods the state began to recognize and take steps to mitigate the animal and public health implications of brucellosis and bTB, but did not make substantial progress until the post-war era, when it instituted nationwide

eradication programmes. With the wartime and post-war campaigns for greater and more efficient food production, it expanded its remit to include the farm-level control and prevention of specific diseases and the so-called diseases of production. This multiple layering of animal health policy was disrupted during the last 20 years of the century. Eradication schemes were practically complete; the perceived threat of epizootic disease reduced with the disappearance of FMD; and re-evaluations of the role of agriculture and its relationship to the state led to an increasing emphasis on industry responsibility for diseases of production and future eradication schemes.

The shifting focus of animal health policy was partly due to a change in disease demographics, which was itself partly precipitated by public policy. This paper has shown how the inter-war marketing boards, the post-war food production drive and the successful interventions of the SVS led to changes to farming practice that sometimes favoured the emergence and spread of disease. This led, in turn, to new (public and private) forms of veterinary intervention. The late twentieth century Conservative government's policy of reducing state support for agriculture and the size of SVS also had implications for livestock health. The intention is not to criticize these policies, or to claim that they were the only factor to influence livestock health, but rather to highlight the co-production of animal health, farming practice and public policy.

However, disease demographics were not the whole story. The emergence and spread of a particular disease did not necessarily make it a focus of policy concern. First, surveillance mechanisms and scientific insights were required to make disease, its incidence and impacts visible. Secondly, those impacts had to be problematized, and thirdly, the state had to assume responsibility for them. As shown in this paper, these processes were influenced by factors such as the national and livestock economy, agricultural policy, veterinary interests and expertise, public health concerns, food security and consumer politics. Scientific and technical progress, while important, can offer only a partial explanation for the historic evolution of farm animal health and public policy.

This research was undertaken as part of a fellowship funded under the UK Research Councils' Rural Economy and Land Use (Relu) Programme (RES-229-27-0001). Relu is funded jointly by the Economic and Social Research Council, the Biotechnology and Biological Sciences Research Council and the Natural Environment Research Council, with additional funding from the Department for Environment, Food and Rural Affairs and the Scottish Government. The author would like to thank these bodies, the editors of this volume, and three anonymous referees for their support and advice.

ENDNOTES

¹The Veterinary Department was formed as the Cattle Plague department in 1865 and placed under the Privy Council. It was transferred to a new Agricultural Department in 1883 which became the Board of Agriculture in 1889. The MAF was formed in 1919, and became the MAFF in 1956. MAFF was replaced by the Department of the Environment, Food and Rural Affairs (Defra) in 2001 [5].

²An epizootic is the animal equivalent of a human epidemic.

³The number of cows in calf or in milk increased by 18.6 per cent between 1871–1875 and 1896–1900, and by 31.6 per cent between 1871–1875 and 1911–1915. The development of rail transport opened up new markets for milk at a time when arable farming faced severe competition from North American imports [16].

⁴The numbers of milking cows in the UK rose from 2 953 000 in 1930 to 3 321 000 in 1939 [29].

⁵Pig numbers in the UK rose from 3.2 million in 1931 to 4.6 million in 1936 [29].

⁶UK dairy cow numbers increased by 76 000 between 1939 and 1942 [29].

⁷Under the 1947 Act, the state maintained its commitment to a stable and productive agriculture. To encourage farmers to invest in high cost items, such as new buildings and machinery, the war-time system of set prices was continued until decontrol in 1953. It was then replaced by a system of guaranteed prices. When market prices fell below the guaranteed price, the state made up the difference. Prices were set annually in consultation with the NFU. The 1957 Act aimed for more efficient production by offering long-term assurances of support while allowing gradual reductions in its value. This strategy, known as the 'cost price squeeze', meant that subsidies no longer fully compensated farmers for their increased costs, so forcing them to make efficiency savings. Other forms of farming support included subsidies on capital and chemical inputs, a free NAAS, and—from the 1960s—grants to amalgamate small farms and to encourage small farmers to leave the industry. As a consequence, the number of agricultural holdings fell from 296 000 in 1950 to 168 000 in 1980, while their average size increased from 34 to 58 ha [44].

⁸Although the term 'preventive medicine' is sometimes used to refer to the range of animal health interventions performed by the state, this account uses the definition adopted by vets and policy makers in the 1960s and 1970s. They viewed veterinary preventive medicine as a veterinary-led, advice-based activity directed at improving herd or flock health through attention to feeding, breeding, housing, hygiene, stockmanship and disease control.

⁹Farmers' incomes and the value of livestock doubled between 1950 and 1960. Livestock numbers also increased: cattle by 10 per cent, sheep by 40 per cent and sows by 100 per cent [53].

¹⁰Leys were temporary pastures sown for grazing, hay or silage making. They became popular in wartime, when farmers were encouraged to plough up permanent pasture, and instead grow crops and ley pasture in alternate years [58].

¹¹The percentage of herds that were machine milked rose from 10 per cent in 1939 to 85 per cent in 1961 [59].

¹²The Veterinary Investigation Service was absorbed into MAF's AHD in 1946. Formerly, officers were attached to university departments of agriculture and agricultural colleges. Eight appointments were made prior to WWII, two during WWII. Six additional centres were established between 1950 and 1964 [2].

¹³Pida was formed in 1957 to promote the technical development of the pig industry. It was subsumed into the Meat and Livestock Commission in 1967 [73].

¹⁴Antibiotic resistance to livestock disease became apparent in the 1950s. Growing fears over its public health implications led MAFF to appoint a Committee of Enquiry into the use of antibiotics in animal husbandry and veterinary medicine. Chaired by Prof. Swann of Bristol University, it reported in 1969 [75].

¹⁵Agricultural output grew more rapidly 1945–1965 than in any period before or since [59].

¹⁶However, the CAP changed the mechanism of support, so that costs were borne largely by the consumer instead of the taxpayer [44].

¹⁷For example, milk production rose from 12 648 million litres in 1970 to over 16 000 million litres in 1984, when quotas were introduced to prevent further expansion in output. Over the same period, pig numbers remained fairly static. However, sheep numbers rose from 26.1 million in 1970 to 41 million in 1988 [29].

¹⁸The term post-productivism encompasses the change in attitudes towards production-oriented agriculture, the belief that the countryside has purposes other than food production, and the

accompanying changes to farming practices and policies. It is a contested concept.

¹⁹The ARC was transformed into the Agriculture and Food Research Council in 1983. It was replaced by the Biotechnology and Biological Sciences Research Council in 1993. Between 1981/1982 and 1987/1988, ARC funding fell by 23 per cent as a result of the government's belief that it should not fund near-market research [107].

²⁰Total livestock exports from the UK rose from just under 950 000 in 1976–1980 to over 1.5 million in 1991–1995. The figure then declined on account of the beef export ban and 2001 FMD epidemic [20].

REFERENCES

- Rosenberg, C. 1992 Framing disease. In *Explaining epidemics* (ed. C. Rosenberg), p. 305. Cambridge, UK: Cambridge University Press.
- Anon. 1965 *Animal health*. London, UK: HMSO.
- Swabe, J. 1999 *Animals, diseases and human society*. London, UK: Routledge.
- Brassley, P. 2008 Murrains to mad cows: a very short history of governments, people and animal diseases. In *The contested countryside: rural politics and land controversy in modern Britain* (eds J. Burchardt & P. Conford), p. 137. London, UK: IB Tauris.
- Winniffrith, J. 1962 *The Ministry of Agriculture, Fisheries and Food*. London, UK: George Allen & Unwin.
- Chief Veterinary Officer 1899 Report. In *Annual report of proceedings under the Diseases of Animals Acts for the year 1898*, pp. 1–7 (Parliamentary Papers. C9208, xviii, 25).
- Perren, R. 1978 *The meat trade in Britain, 1840–1914*. London, UK: Routledge.
- Fisher, J. 1980 The economic effects of cattle disease in Britain and its containment, 1850–1900. *Agric. Hist.* **54**, 278–294.
- Fisher, J. 2003 To kill or not to kill: the eradication of contagious bovine pleuro-pneumonia in western Europe. *Med. Hist.* **47**, 314–331.
- Woods, A. 2004 *A manufactured plague*. London, UK: Earthscan.
- Woods, A. In preparation. Defining the boundaries of veterinary expertise: contagious disease control at the British Board of Agriculture, 1890–1922.
- Worboys, M. 1991 Germ theories of disease and British veterinary medicine. *Med. Hist.* **35**, 308–327.
- Waddington, K. 2006 *The bovine scourge: meat, tuberculosis and public health, 1850–1914*. Woodbridge, VA: Boydell Press.
- Woods, A. 2009 'Partnership' in action: contagious abortion and the governance of livestock disease in Britain, 1885–1921. *Minerva* **47**, 195–217. (doi:10.1007/s11024-009-9123-5)
- Taylor, D. 1987 Growth and structural change in the English dairy industry, ca 1860–1930. *Agric. Hist. Rev.* **35**, 47–64.
- Brown, J. 1987 *Agriculture in England: a survey of farming 1870–1947*. Manchester, UK: Manchester University Press.
- Waddington, K. 2004 'To stamp out so terrible a malady': bovine tuberculosis and tuberculin testing in Britain, 1890–1939. *Med. Hist.* **48**, 29–48.
- Pattison, I. 1981 *John McFadyean, founder of modern veterinary research*. London, UK: J.A. Allen.
- Woods, A. 2007 The farm as clinic: veterinary expertise and the transformation of dairy farming, 1930–50. *Stud. Hist. Phil. Biol. Biomed. Sci.* **38**, 462–487. (doi:10.1016/j.shpsc.2007.03.009)
- Perren, R. 2006 *Taste, trade and technology: the development of the international meat industry since 1840*. Aldershot, UK: Ashgate.
- Hardy, A. 2003 Professional advantage and public health: British veterinarians and state veterinary services, 1865–1939. *Twentieth Century Brit. Hist.* **14**, 1–23. (doi:10.1093/tcbh/14.1.1)
- Jones, S. 2004 Mapping a zoonotic disease: Anglo-American efforts to control bovine tuberculosis before World War I. *Osiris* **19**, 133–148. (doi:10.1086/649398)
- Anon. 1967 The Central Veterinary Laboratory, Weybridge. 1917–67. *Vet. Rec.* **81**, 62–68. (doi:10.1136/vr.81.3.62)
- Trentmann, F. 2001 Bread, milk and democracy: consumption and citizenship in twentieth century Britain. In *The politics of consumption: material culture and citizenship in Europe and America* (eds M. Daunton & M. Hilton), pp. 129–163. Oxford, UK: Berg Publishers.
- Economic Advisory Council 1933–1934 Committee on cattle diseases: report (Parliamentary Papers. Cmd 4591, iv, 427).
- French, M. & Phillips, J. 2000 Conflicts of interest: milk regulation, 1875–1938. In *Cheated not poisoned? Food regulation in the United Kingdom 1875–1938* (eds M. French & J. Phillips), pp. 158–184. Manchester, UK: Manchester University Press.
- Atkins, P. 2000 The pasteurisation of England: the science, culture and health implications of milk processing, 1900–50. In *Food, science, policy and regulation in the 20th century: international and comparative perspectives* (eds D. Smith & J. Phillips), pp. 37–51. London, UK: Routledge.
- Baker, S. 1973 *Milk to market: forty years of milk marketing*. London, UK: Heinemann.
- Marks, H. F. & Britton, D. K. 1989 *A hundred years of British food and farming: a statistical survey*. London, UK: Taylor and Francis.
- Anon. 1936 Milking machines and their relationship to mastitis in cows. *Vet. Rec.* **48**, 305.
- Practitioner 1939 Disease in 'flying' herds. *Home Farmer* **6**, 31.
- Bellis, D. B. 1968 Pig farming in the United Kingdom—its development and future trends. *J. R. Agric. Soc. Engl.* **129**, 24–42.
- Lamont, H. G. 1938 The problems of the practitioner in connection with the differential diagnosis and treatment of diseases in young pigs. *Vet. Rec.* **50**, 1379–1400.
- Anthony, D. 1935 Some notes on swine practice. *Vet. Rec.* **47**, 75–84.
- Lamont, H. G. 1956 Pig housing and health. In *A. A. McGuckian: a memorial volume* (ed. A. E. Muskett), pp. 105–122. Belfast, UK: McGuckian Memorial Committee.
- MAF Statistics and Economics Division 1942 Reports on the economic position of agriculture, no. 18: hill farming in England and Wales. National Archives (hereafter NA) MAF 112/159.
- Chief Veterinary Officer. 1937 *Report: annual report of proceedings under the diseases of animals acts*. London, UK: HMSO.
- Cabot, D. 1939 The national veterinary service. *Vet. Rec.* **51**, 1030–1034.
- DeJager, T. 1993 Pure science and practical interests: the origins of the ARC, 1930–37. *Minerva* **13**, 129–151. (doi:10.1007/BF01125432)
- Dalrymple-Champneys, W. 1932 Undulant fever. *Lancet* **219**, 791–792. (doi:10.1016/S0140-6736(01)24749-7)
- Ministry of Information. 1945 *Land at war: the official story of British farming 1939–44*. London, UK: HMSO.
- Hammond, R. J. 1954 *Food and agriculture in Britain, 1939–45*. Stanford, CA: Stanford University Press.

- 43 Murray, K. 1955 *The history of the Second World War: agriculture*. London, UK: HMSO.
- 44 Martin, J. 2000 *The development of modern agriculture: British farming since 1931*. Basingstoke, UK: Macmillan.
- 45 Powley, J. O. 1942 Diseases of the pig with reference to war-time conditions. *Vet. Rec.* **54**, 236–238.
- 46 Bellis, D. B. 1963 The role of commercial companies in modern farm husbandry. *Vet. Rec.* **75**, 1291–1300.
- 47 Agricultural Improvement Council 1942 Minutes of committee on hill sheep farming. NA MAF 52/235.
- 48 MAFF 1940 Correspondence on provision of sheep vaccines and sera. NA MAF 35/570.
- 49 Various 1942–44 Area 1: hill sheep diseases survey. NA MAF 35/639.
- 50 Winter, M. 1996 *Rural politics: policies for agriculture, forestry and the environment*. London, UK: Routledge.
- 51 Robertson, I. 2008 The eradication of classical swine fever in Great Britain. Presentation to *FAO-ADB Workshop on Legislative and Strategic Aspects of EID Control*, Bangkok.
- 52 Madden, E. 1984 *Brucellosis: a history of the disease and its eradication from cattle in Great Britain*. London, UK: MAFF.
- 53 Ewer, T. K. 1962 The veterinary surgeon in relation to animal husbandry. *Vet. Rec.* **74**, 1141–1147.
- 54 Wright, J. G. 1961 The veterinary profession, past present and future. *Vet. Rec.* **73**, 224–226.
- 55 MAFF 1964 Submission of evidence to committee on recruitment to the veterinary profession. NA MAF 184/226.
- 56 White, E. G. 1961 The future of the profession in Great Britain. *Vet. Rec.* **73**, 526–528.
- 57 White, J. B. 1963 President's address to the Association. *Vet. Rec.* **75**, 987–990.
- 58 Stapledon, G. 1939 *The plough up policy and ley farming*. London, UK: Faber and Faber.
- 59 Brassley, P. 2000 Output and technical change in twentieth century British agriculture. *Agric. Hist. Rev.* **48**, 60–84.
- 60 Wooldridge, W. R. 1954 *Farm animals in health and disease*. London, UK: Crosby Lockwood.
- 61 Dalling, T. 1956 *The impact of modern farm husbandry on animal health*. Belfast, UK: Marjory Boyd.
- 62 Waddington, F. G. 1959 The profession today and tomorrow. *Vet. Rec.* **71**, 434–437.
- 63 Technical Development Committee of the British Veterinary Association 1966 Intensive livestock husbandry. *Vet. Rec.* **78**, 549–560, 586–590, 616–623. (doi:10.1136/vr.78.16.549)
- 64 Wilmot, S. 2007 From 'public service' to artificial insemination: animal breeding science and reproductive research in early twentieth-century Britain. *Stud. Hist. Phil. Biol. Biomed. Sci.* **38**, 411–441. (doi:10.1016/j.shpsc.2007.03.007)
- 65 Paterson, A. B. 1973 Animal health. *Phil. Trans. R. Soc. Lond. B* **267**, 113–130. (doi:10.1098/rstb.1973.0066)
- 66 Grey, D. E. & Stebbings, M. E. 1962 An annotated bibliography of surveys on the incidence of disease of farm animals and birds in Great Britain published during 1931–61. *Br. Vet. J.* **118**, 395–402.
- 67 Beynon, V. H. 1963 The role of the veterinary surgeon in British agriculture. *Vet. Rec.* **75**, 1436–1448.
- 68 Morris, R. S. 1969 Assessing the economic value of veterinary services to primary industries. *Aust. Vet. J.* **45**, 295–300. (doi:10.1111/j.1751-0813.1969.tb01955.x)
- 69 Jack, L. 2006 Protecting agricultural accounting in the UK. *Accounting forum* **30**, 227–243. (doi:10.1016/j.accfor.2006.03.003)
- 70 White, J. B. 1961 The veterinary surgeon in practice and his need for laboratory services. *Vet. Rec.* **73**, 1198–1200.
- 71 Blount, W. 1968 *Intensive livestock farming*. London, UK: Heinemann.
- 72 Melrose, D. 1963 PIDA—its functions and association with veterinary research. *Vet. Rec.* **75**, 904–905.
- 73 Cooke, G. W. (ed.) 1963 *Agricultural research 1931–81*. London, UK: Agricultural Research Council.
- 74 Blaxter, K. & Robertson, N. 1995 *From dearth to plenty: the modern revolution in food production*. Cambridge, UK: Cambridge University Press.
- 75 Bud, R. 2007 *Penicillin: triumph and tragedy*. Oxford, UK: Oxford University Press.
- 76 McCann, N. 1989 *The story of the National Agricultural Advisory Service*. Ely, UK: Providence Press.
- 77 MAFF 1964–5 Review of animal health policy. NA MAF 287/352.
- 78 Animal Health Division 1961–3 Working Party to consider nationalised veterinary service. NA MAF 287/101.
- 79 Animal Health Division 1963–4 Working Party to consider nationalised veterinary service NA MAF 287/102.
- 80 MAFF 1964–5 Annual review and determination of guarantees. Parliamentary Papers. Cmnd 2621: 140.
- 81 South West Study Group 1965–72 Minutes of meetings. NA MAF 109/286.
- 82 MAF 1964 Appointment of joint study group of Animal Health Division and National Farmers Union. NA MAF 287/259.
- 83 MAFF 1965 Review of animal health policy. NA MAF 287/353.
- 84 MAFF 1965–6 Review of animal health policy. NA MAF 287/354.
- 85 MAFF 1975 Report on the joint exercise in animal health and productivity. London, UK: HMSO.
- 86 Committee of Inquiry into the Veterinary Profession. 1975 Report, vol. I. London, UK: HMSO. (Cmnd. 6143)
- 87 Swann Report Working Group 1975–6 Report and correspondence. NA MAF 425/1.
- 88 Betts, A. 1961 Pathogen free pigs for research and the practical control of pig diseases. *Vet. Rec.* **73**, 1349–1361.
- 89 Godley, A. & Corley, T. In press. The veterinary medicine industry in Britain during the twentieth century. *Econ. Hist. Rev.*
- 90 Body, R. 1982 *Agriculture: the triumph and the shame*. London, UK: Temple Smith.
- 91 Winter, M. 1996 *Rural politics: policies for agriculture, forestry and the environment*. London, UK: Routledge.
- 92 Wilson, G. 2002 From productivism to post-productivism ... and back again? Exploring the (un)changed natural and mental landscapes of European agriculture. *Trans. Inst. Br. Geogr.* **26**, 77–102. (doi:10.1111/1475-5661.00007)
- 93 Von Borell, E. & Sorenson, J. T. 2004 Organic livestock production in Europe: aims, rules and trends with special emphasis on animal health and welfare. *Livestock Prod. Sci.* **90**, 3–9. (doi:10.1016/j.livprodsci.2004.07.003)
- 94 Esslemont, R. J. & Kossaibati, M. A. 1996 Incidence of production diseases and other health problems in a group of dairy herds in England. *Vet. Rec.* **139**, 486–490. (doi:10.1136/vr.139.20.486)
- 95 Whitaker, D. A., Kelly, J. M. & Smith, S. 2000 Disposal and disease rates in 340 British dairy herds. *Vet. Rec.* **146**, 363–367. (doi:10.1136/vr.146.13.363)
- 96 Phillips, L. 2000 Report, evidence and supporting papers of the inquiry into the emergence and identification of Bovine Spongiform Encephalopathy (BSE) and variant Creutzfeldt-Jakob Disease (vCJD) and the action taken in response to it up to 20 March 1996. London, UK: HMSO.

- 97 Zwanenberg, P. & Millstone, E. 2005 *BSE: risk, science and governance*. Oxford, UK: Oxford University Press.
- 98 CVO 1983 Report: animal health 1982. London, UK: HMSO.
- 99 CVO 1987 Report: animal health 1986. London, UK: HMSO.
- 100 CVO 1988 Report: animal health 1987. London, UK: HMSO.
- 101 Lebrecht, A. 1993 Stage 2 report: proposals for changes in functions of the Animal Health and Veterinary Group of MAFF. Unpublished document, presented in evidence to Phillips [96].
- 102 CVO 1996 Report: animal health 1995. London, UK: HMSO.
- 103 Farm Animal Welfare Council 2005 Report on the welfare implications of farm assurance schemes. See <http://www.fawc.org.uk/pdf/fas-report05.pdf>.
- 104 Barrett, D. C. 2001 Biosecurity and herd health. *Cattle Practice* **9**, 97–103.
- 105 Grant, W. 2009 Intractable policy failure: the case of bovine TB and badgers. *Br. J. Polit. Int. Relations* **11**, 557–573. (doi:10.1111/j.1467-856X.2009.00387.x)
- 106 Anderson, I. 2002 FMD 2001: lessons to be learned enquiry report. London, UK: HMSO.
- 107 Thirtle, C., Palladino, P. & Piesse, J. 1997 On the organization of agricultural research in the United Kingdom, 1945–94: a quantitative description and appraisal of recent reforms. *Res. Policy* **26**, 557–576. (doi:10.1016/S0048-7333(97)00031-0)